CLAIMS

1, An elevationally focused ultrasonic probe comprising an array of MUT cells.

2. The probe as recited in claim 1, further comprising a curved lens adhered to said array of MUT cells, and a planar substrate, said MUT cells being built on said substrate.

3. The probe as recited in claim 2, further comprising a layer of adhesive material between said lens and said array.

4. The probe as recited in claim 3, further comprising a barrier layer disposed between said layer of adhesive material and said array of MUT cells, said barrier layer being made of a material that prevents chemical diffusion from said lens to said MUT cells.

5. The probe as recited in claim 1, further comprising a curved substrate, said MUT cells being built on said substrate, and a layer of protective material covering said array of MUT cells.

6. The probe as recited in claim 1, wherein said array comprises a first multiplicity of MUT cells hard-wired together and a second multiplicity of MUT cells hard-wired together.

7. The probe as recited in claim 6, wherein said MUT cells of said first multiplicity are arranged side by side and cover a generally rectangular area, the length of said rectangle being aligned with an elevation direction, said lens being curved in said elevation direction.

8. The probe as recited in claim 1, wherein said lens is cylindrical, multifocal or elliptical.

9. The probe as recited in claim 2, further comprising adhesion promoting material applied on a front face of said array or on a rear face of said lens or both.

10. The probe as recited in claim 5, further comprising adhesion promoting material applied on a front face of said array or on a surface of said protective layer that faces said array.

11. The probe as recited in claim 2, wherein said lens is made of a polymeric material.

12. The probe as recited in claim 11, wherein said lens is made of silicone rubber and said adhesive material is made of room-temperature vulcanizing silicone rubber.

13. The probe as recited in claim 9, wherein said adhesion-promoting material is a silicate.

14. The probe as recited in claim 9, wherein said adhesion-promoting material is an organometallic.

15. The probe as recited in claim 9, wherein said adhesion-promoting material is a reactive organosilane.

16. The probe as recited in claim 1, wherein each of said MUT cells is a capacitive MUT cell.

17. The probe as recited in claim 1, wherein each of said MUT cells is a piezoelectric MUT cell.

18. The probe as recited in claim 1, further comprising:

a layer of CMOS electronics below said array of MUT cells; and

a silicon substrate below said layer of CMOS electronics.

19. An ultrasonic probe comprising:

a curved substrate having a profile that is substantially constant in an azimuthal direction;

an array of MUT cells built on said curved substrate and facing toward a line of focus, said MUT cells being disposed on a concave side of said curved substrate; and

a layer or protective material applied on the face of said array of MUT cells, said layer having a substantially constant thickness or has a flat top surface and a bottom surface that follows the curvature of the substrate, if the speed of sound in the protective material is generally equal to the speed of sound in water or tissue.

20. The probe as recited in claim 19, wherein each of said MUT cells is a capacitive MUT cell.

21. The probe as recited in claim 19, wherein each of said MUT cells is a piezoelectric MUT cell.

22. A lensing process comprising the following steps:

(a) micromachining an array of ultrasonic transducer cells on a substrate;

(b) applying a layer of adhesive material on a preformed curved lens or on a surface of said micromachined substrate;

(c) placing said lens in abutment with said micromachined substrate with said layer of adhesive material therebetween; and

(d) curing said adhesive material.

23. The process as recited in claim 22, further comprising the step of applying a low pressure less than 50 psi during curing.

24. The process as recited in claim 22, wherein curing occurs at a temperature higher than room temperature.

25. The process as recited in claim 22, further comprising the step, performed before step (c), of cleaning the surfaces of said lens and said micromachined substrate that will be in contact with the adhesive material.

26. The process as recited in claim 25, wherein said cleaning step comprises exposing said surfaces to an oxygen-containing plasma.

27. The process as recited in claim 22, further comprising the steps, performed before step (c), of applying a layer of adhesion-promoting material to one or both of the surfaces of said lens and said micromachined substrate that will be in contact with the adhesive material.

28. The process as recited in claim 27, wherein said adhesion-promoting material is a silicate.

29. The process as recited in claim 27, wherein said adhesion-promoting material is an organometallic.

30. The process as recited in claim 27, wherein said adhesion-promoting material is a reactive organosilane.

31. The process as recited in claim 22, further comprising the step, performed before step (b), of depositing a layer of barrier material on the surface of said micromachined substrate that will be in contact with the adhesive material, said barrier material having the property of preventing chemical diffusion into said micromachined substrate.

32. A lensing process comprising the following steps:

(a) micromachining an array of ultrasonic transducer cells on a substrate;

(b) casting lensing material on a surface of said micromachined substrate; and

(c) curing said lensing material.

33. The process as recited in claim 32, further comprising the step, performed before step (b), of cleaning the surface of said micromachined array.

34. The process as recited in claim 33, further comprising the steps of applying a layer of adhesion-promoting material to said cleaned surface.

35. The process as recited in claim 34, further comprising the step of depositing a layer of barrier material on the surface of said micromachined array, said barrier material having the property of preventing chemical diffusion into said micromachined substrate.

36. A method of making a curved ultrasonic probe, comprising the following steps:

(a) micromachining an array of ultrasonic transducer cells on a substrate; and

(b) bending said substrate to have a predetermined curvature suitable for focusing ultrasonic beams emitted by said array in an elevational direction.

37. The method as recited in claim 36, further comprising the step of thinning said substrate after step (a) and before step (b).

38. The method as recited in claim 36, further comprising the step of applying a layer of protective material on a face of said array.

39. An integrated device comprising:

a curved lens;

a first multiplicity of MUT cells hard-wired together and disposed underneath said lens;

a second multiplicity of MUT cells hard-wired together and disposed underneath said lens;

CMOS electronics disposed underneath said first and second multiplicities of MUT cells; and

a silicon substrate disposed underneath said CMOS electronics.

40. The device as recited in claim 39, wherein each of said MUT cells is a capacitive MUT cell.

41. The device as recited in claim 39, wherein each of said MUT cells is a piezoelectric MUT cell.